Section 921. PERMANENT TRAFFIC SIGNAL MATERIALS

921.01 Sampling and Testing.

A. **General.** Permanent traffic signal materials covered by this section may be selected at random from any shipment and tested according to Department methods. If notified by the Department, the Contractor shall complete one installation for preliminary testing. If the preliminary sample does not conform to these specifications, the Contractor will be notified, in writing, of all deficiencies so that the necessary changes or corrections may be made in materials or installation methods. All traffic signal materials will then be subject to re-testing by the Department.

B. **Loop Detectors.** One or more loop detectors shall be selected at random from the shipment and tested as described in subsection 921.01.A. If this one loop detector conforms to these specifications, the Contractor will be notified in writing and shall furnish the remainder of the order, which will be subject to testing. If the preliminary sample does not conform to these specifications, the Contractor will be notified, in writing, of all deficiencies so that the necessary changes or corrections may be made in materials or installation methods. All loop detectors will then be subject to testing. If the necessary corrections are not or cannot be made, the Contractor will be required to provide acceptable materials from other sources as specified by section 105.

921.02 Span Wire. All span wire shall be Extra High-Strength Grade, 7 Class A zinc-coated steel wires per strand, meeting ASTM A 475. Wire supporting traffic signal cable only shall have a nominal diameter of ¼ inch. Wire supporting a traffic signal, case sign and cable shall have a nominal diameter of $^{5}/_{16}$ inch.

921.03 Vehicular Traffic Signals and Mounting Assemblies. Except as otherwise noted, traffic signals shall conform with the requirements of the *Standard for Adjustable Face Vehicle Traffic Control Signal Heads*, of the Institute of Traffic Engineers, (ITE Standard).

Traffic signals shall be adjustable face type with 8 or 12-inch diameter lenses. All signal sections of the same make and type shall be interchangeable. A signal face includes housing, visors, optical units, wiring and mounting assembly.

A. **Housing.** The housing shall be polycarbonate plastic. Each signal body shall have a 2-inch diameter hole top and bottom to receive 1½-inch diameter supporting pipe. All fasteners, such as screws, bolts, nuts, hinge pins and clamps, which are partially or wholly exposed on the exterior of the assembled housing, shall be AISI Series 300 stainless steel. Screws, bolts, nuts and hinge pins on the interior of the housing shall be AISI Series 300 stainless steel. Other hardware used on the interior shall be AISI Series 300 stainless steel, brass or aluminum. Plastic fasteners shall not be used to secure the door.

B. **Visor.** Each signal face shall have a detachable tunnel design visor for each signal lens. The visor shall be 7 to 8 inches in length for the 8-inch lens and 9½ to 12 inches in length for the 12-inch lens. The visor shall enclose not less than 290 degrees of the lens circumference and shall tilt downward between 1 and 10 degrees. The visor shall be of

polycarbonate with a minimum thickness of 0.078 inches. The visor shall be attached to the signal section.

C. **Optical Unit.** The optical unit consists of the lamp and lamp receptacle, reflector, and lens. The candlepower and light distribution of the 8-inch optical units shall be a minimum of 0.8 of the values given in the ITE Standard. The candlepower and light distribution of the 12-inch optical unit shall be as specified in the ITE Standard for the standard wide angle lens. The entire optical unit when assembled shall be mounted in the housing so that it is independently sealed against dust and moisture.

1. **Lamp and Lamp Receptacle.** A 130-volt 69-watt A21 lamp for an 8-inch lens and a 130-volt, 1950 lumen, P25 lamp for a 12-inch lens shall be provided for each optical unit.

   The lamp receptacle shall be a fixed focus type and shall conform to the National Board of Fire Underwriters Electrical Code and the ITE Standard. The lamp socket shall be secured to the reflector in such a manner that it does not turn when replacing lamps and that it can be removed or replaced without the use of tools other than a screwdriver. The lamp receptacle may be rotated for positioning the lamp filament.

2. **Reflector.** The reflector shall be made of aluminum with a sealed anodic coating over an electrolytically brightened surface. The coating thickness shall conform to the ITE Standard.

   The reflector mounting shall be designed and constructed as to assure proper alignment between the lens and reflector. To maintain this position, the reflector shall remain in a fixed position when the door of the housing is open or when inserting or removing a lamp. The reflector mounting shall be sufficiently rigid, so that forces applied to the lamp during the maintenance will not unseat the reflector.

3. **Lens**. The lens shall be circular with nominal 8- or 12-inch diameter. Each signal face, consisting of three optical units, shall be supplied with red, yellow and green lenses, in that order, with the red lens at the top. Lens shall display a true color when illuminated and the outer surface shall be convex and smooth. They shall conform to the requirements for Traffic Signal Lenses in Paragraph 6 of the ITE Standard.

   Lenses shall be made of polycarbonate plastic capable of withstanding continuous illumination from lamps of designated wattage without damage to the lens.

   The lens shall be securely mounted to the housing door to assure alignment and a neoprene gasket shall be provided between the door and the lens.

D. **Electrical Wiring.** The electrical wiring shall consist of stranded wire and shall conform to the requirements of the ITE Standard. Each signal shall be equipped with a barrier type terminal block with a minimum of four terminals; one for each optical unit and one common terminal. The terminal block shall be mounted in the center section in such a position as not to interfere mechanically with other components of the signal. The terminal block shall

be located in the housing as to minimize the danger of electrical shock to personnel performing maintenance on the signal head.

The wiring shall be fastened to the lamp receptacle so as to be electrically and mechanically secure. All exposed current carrying parts shall be sufficiently insulated to prevent electrical shock hazard. Pre-insulated terminals shall be used on the wires at the terminal block connection.

Pressure type terminal blocks will not be permitted.

E. **Mounting Assemblies.** Mounting assemblies shall include all hardware for a complete assembly of the signal.

1. **Pipe.** Pipe used in mounting assemblies shall be 1½-inch standard steel pipe with tapered threads. No straight threads will be allowed. All exposed pipe threads shall have a plastic thread protector installed to help protect the threads from damage during shipping.

2. **Hub or Center Fitting.** The hub shall be malleable iron and have a nominal 3 by 3 inch opening in which to draw wires and make connections. The cover for the opening shall be secured with two ⅜ by ½ inch hexagon head 300 Series stainless steel screws. Any unused openings in the hub shall be closed with ferrous or aluminum ornamental closures.

3. **Arms.** Pipe arms from the center hub shall be of such lengths that the centers of the signal face housings will be at a radius of 8¾ inches ± ¼ inch for the 8-inch signals and 10¾ inches ± ¼ inch for the 12-inch signals from the center of the hub fitting.

4. **Fittings.** Ferrous pipe crosses shall be used to make all right angles in mounting frames with unused openings closed with ornamental closures. No set screws will be allowed in the pipe crosses.

   All malleable iron fittings shall be free from any flash and be free of any voids.

5. **Assemblies.** The bottom portion of the side post mounting assemblies shall be constructed of 1½-inch standard steel pipe and fittings. The bottom portion of the span mounting assemblies shall be a flat aluminum spacer with aluminum closures for attachment to signals. This spacer shall be one piece construction or welded. Rivets are not permitted.

6. **Finish.** The internal surface of all pipe and fittings shall be free from sharp edges and burrs that would injure the wiring.

7. **Cable Entrance Fitting.** The fitting shall be one piece construction and made of malleable iron. The wire outlet shall be provided with a composition bushing with opening to accommodate a multiconductor cable one inch in diameter. The threaded end of the fitting shall be provided with a threaded nipple, two 1½-inch malleable iron locknuts and a stainless steel cotter key.

8. **Span Wire Fitting.** The fitting shall be malleable iron to accommodate ¼ to ⅜ inch messenger wire with a 1⅝-inch diameter pin and 3/32 by 1 inch stainless steel cotter key. This pin shall be located 3 7/16 inches from where the span cable seats into the saddle part of this fitting. The length of the saddle part shall be 9 inches.

9. **Span and Cable Entrance Assembly.** This assembly shall be capable of allowing the signal assembly to swing in any direction and return to the vertical position without placing undue stress on the span wire.

10. **Signal Head Attachment.** The top outlet of each signal bracket shall be furnished with a nipple and either of the following: a watertight metal gasket with retainer to restrict the flow of the gasket, or one flat stainless steel washer, and one malleable iron hexagon nut ½ inch thick.

    The nipple shall be of sufficient length to allow the use of the gasket or nut and washer.

F. **Paint and Color.**

1. **Mounting Assemblies.** Surfaces of mounting assemblies shall be cleaned and surface treated according to standard industry practice to assure bonding of the paint to the metal. After preparation, surfaces shall be painted with durable weather resistant semi-gloss or gloss yellow enamel.

   The enamel shall be applied at an average dry film thickness of 1.5 mils without blisters, runs or other defects. The dry film thickness shall be determined by Method A, Inductance Thickness Gage, as specified in ASTM D 1400. The color shall match the central color within the limits shown on the current FHWA *Highway Yellow Color Tolerance Chart* except that the color shall not be darker than the central color.

2. **Signal Faces.** The signal faces shall have the yellow color specified above permanently molded into the signal door, housing and visors. The inside of the visors shall be given a finish coat of flat black paint which is compatible with polycarbonate plastic.

G. **Packing and Marking.** Each traffic signal shall be packed separately in such a manner that there will be no injury or defacement to the signal and mounting assembly during transportation to the project site. Each carton shall be legibly marked with the signal and mounting assembly description and supplier's name.

921.04 Pedestrian Signal (Incandescent Type). Except as otherwise noted, pedestrian signals shall conform to the requirements for nominal 9 by 9 inch or 12 by 12 inch incandescent type pedestrian signals as specified in the ITE *Standard for Adjustable Face Pedestrian Signal Heads*. The pedestrian signal head shall be designed for operation on 120-volt, 60-cycle, single-phase AC electrical systems.

A. **Housing.** The housing shall be made of polycarbonate and conform to the requirements given under "Housing" in the ITE Standard except that unitized sectional construction will not be required. Each housing shall have a 2-inch diameter round hole top and bottom to

receive a 1½-inch supporting pipe. All fasteners such as screws, bolts, nuts, hinge pins and clamps, which are partially or wholly exposed on the exterior of the assembled housing shall be of AISI Series 300 stainless steel. Other screws, bolts, nuts, and hinge pins on the interior of the housing shall be of AISI Series 300 stainless steel, brass or aluminum. Plastic fasteners shall not be used to secure the door.

B. **Visor.** Each signal head shall have a tunnel type visor for each signal indication which encompasses the top and two sides of the lens. The visor shall be made of sheet polycarbonate having a thickness of not less than 0.070 inches. The visor shall fit tightly against the door and shall not permit any perceptible filtration of light between the door and the visor. The visor shall be detachable and shall be 8 to 10 inches in length. The visor shall be attached to the signal section.

C. **Optical Unit.** The optical unit consists of the lamp and lamp receptacle, reflector, and lens. The entire optical unit when assembled shall be mounted in the housing so that it is independently sealed against dust and moisture.

1. **Lamp and lamp receptacle.** The lamp receptacle shall be secured to the reflector in such a manner that it does not turn when replacing lamps and that it can be removed or replaced without the use of tools other than a screwdriver. The lamp receptacle may be rotated for positioning the lamp filament. The lamp receptacle and wiring shall meet the ITE Standard.

   The candlepower and light distribution of the nominal 9 by 9 inch and 12 by 12 inch optical unit shall be as specified in the ITE Standard for the standard symbolic pedestrian lens.

   The lamp receptacle shall conform to the requirements given in the ITE Standard with the following additions:

   The lamp receptacle shall be held securely in the reflector by a device such as a clamp ring or ball. Means other than friction shall be employed to prevent the lamp receptacle from turning when replacing lamps. It shall be possible to remove or replace the receptacle without the use of tools other than a screwdriver and without removing the holding device or parts of the holding device from its mounting. The lamp will be a 130-volt, 69-watt, Type A 21, clear traffic signal lamp for the nominal 9-inch signals, and will be a 130-volt, 116-watt, Type A 21, clear traffic signal lamp for the nominal 12-inch signals.

2. **Reflector.** The reflector mounting shall be designed and constructed to ensure proper alignment between the lens and reflector. To maintain this position, the reflector shall remain in a fixed position when the door of the housing is open or when inserting or removing a lamp. The reflector mounting shall be sufficiently rigid, so that forces applied to the lamp during maintenance will not unseat the reflector.

   The reflector shall be made of aluminum with a sealed anodic coating over an electrolytically brightened surface. The coating thickness shall conform to the

requirements of ITE Standard. The reflector shall be designed to redirect the light from a standard signal lamp to provide uniform illumination over the surface of the lens.

The reflector mounting shall be designed and constructed to ensure proper alignment between the lens and the reflectors. This correct alignment shall be maintained after opening and closing the door for lamp replacement and other maintenance functions. The reflector shall be mounted in the housing section and remain in a fixed position when the door of the housing is opened or when inserting or removing a lamp. The reflector mounting shall be sufficiently rigid that any focusing, tipping, turning or pushing applied to the lamp will not cause the reflector to become unseated.

3. **Lens.** The lens shall be securely mounted to the housing door to assure alignment. A neoprene gasket shall be provided between the door and the lens.

   The lenses shall be nominal 9 by 9 inch or 12 by 12 inch conforming to the ITE Standard and the following provisions:

   DON'T WALK. The lens shall be portland orange polycarbonate symbolic.

   WALK. The lens shall be lunar white polycarbonate symbolic.

   The entire surface of the lens, except for the message, shall be covered by an opaque black enamel, capable of totally hiding the light of a 150-watt lamp placed within 12 inches of the back surface of the lens.

   The lens manufacturer shall place a label on each lens which states that the lens meet the ITE Standard.

   The lens shall be mounted in such a way that secure tightening of set screws or other means of holding the lens in the lens frame will not crack the lens.

D. **Electrical Wiring.** The electrical wiring shall consist of stranded wire and shall conform to the ITE Standard. Each pedestrian signal shall be equipped with a barrier type terminal block with a minimum of 3 terminals, one for each optical unit and one common terminal. The terminal block shall be mounted in such a position as not to interfere mechanically with the other components of the signal. The wiring shall be fastened to the lamp receptacle so as to be electrically and mechanically secure. All exposed current-carrying parts shall be sufficiently insulated to prevent electrical shock hazard. Pre-insulated terminals shall be used on the wires at the terminal block connection. Pressure type terminal blocks will not be permitted.

E. **Mounting Bracket Frame Assembly and Fitting.** The mounting frame assembly and fittings shall be constructed to be entirely weather-tight. The arms of the mounting assembly shall be 1½-inch standard steel pipe and of such lengths as to provide the following dimensions within a tolerance of ±¼ inch.

   a. Radius from center of hub to center of pipe cross for overhead and pedestal mountings: 8¾ inches.

b. Length from center of the first pipe cross: 11½ inches for both "I" and "T" type brackets.

The internal surfaces of all pipe and fittings shall be free from sharp edges and burrs that could injure the wiring. Ferrous pipe crosses shall be used to make all right angles in the mounting assembly, and the unused openings of the pipe crosses shall be closed with ornamental closures. Adapters or slip fitters shall be malleable iron.

All malleable iron fittings shall be free from any flash and be free of any voids.

All exposed pipe threads shall have a plastic thread protector installed to help protect the threads from damage during shipping.

F. **Painting Requirements.** Prior to painting the mounting brackets, the ferrous and aluminum surfaces shall be cleaned and treated according to standard industry practice for each type of metal to assure bonding of the paint to the metal.

The coating system for the mounting bracket assembly shall consist of durable and weather-resistant black enamels and shall be applied at a uniform thickness without blisters, runs, or other defects. The average dry film thickness shall be 1.5 mils as determined by Method A, Inductance Thickness Gage, as specified in ASTM D 1400 .

A flat black enamel which is compatible with polycarbonate plastic shall be used to finish coat the inside surface of visors. Polycarbonate molding or assemblies shall have the black color as a constituent of the plastic.

G. **Packing and Marking.** Each pedestrian signal shall be packed separately in such a manner that there will be no injury or defacement to the pedestrian signal and mounting assembly during transportation to the project site. Each carton shall be legibly marked with the pedestrian signal and mounting assembly description and supplier's name.

921.05 Traffic Signal Strain Pole.

A. **Shaft Assembly and Fabrication.**

1. The shaft shall be fabricated from high strength steel according to ASTM A 572, Grade 345 and galvanized after fabrication according to ASTM A 123.

2. The shaft shall be tapered and may be of circular or polygonal (with eight or more sides) cross section.

3. The shaft shall be of one continuous length with not more than one longitudinal weld. The longitudinal weld shall be rolled or ground smooth. Transverse welds will not be accepted except where the anchor base is welded to the shaft.

4. The shaft shall be attached by two continuous welds to an ASTM A 36 or approved equal steel anchor base. One weld shall be on the inside of the base at the end of the shaft and the other weld shall be on the outside at the top of the base. The two welds shall be not less than 2 inches apart. The base and welded connection shall develop the full strength of the shaft.

5. The base shall have four evenly spaced holes so that the standard may be bolted to a concrete foundation. Thirty - and thirty-six foot poles require holes for four 1¾- inch anchor bolts on a bolt circle of 18 inches. Forty - foot poles require holes for four 2- inch anchor bolts on a bolt circle of 18 inches diameter.

6. Covers shall be furnished for the anchor bolt ends and nuts. Screws for attaching the covers shall be stainless steel hex head cap screws. Anchor bolt ends and nuts shall be greased with a non-oxide type grease.

7. A handhole opening and cover shall be provided. The handhole opening shall have a reinforcing frame welded to the shaft. The handhole shall not reduce the strength of the shaft. The handhole cover shall be securely fastened by stainless steel hex head cap screws or by an approved locking device.

8. The lower surface of the base shall be finished flat and the base shall be attached at 90 degrees to the shaft axis. The base shall have a clear opening at least 6½-inch diameter to allow entrance of cables from two 3-inch ducts into the foundation.

9. A suitable pole top shall be furnished and shall be provided with means for securing it to the top of the shaft.

10. A hook or other suitable device for the support of cable shall be provided on the inside of the shaft near the top.

11. For grounding purposes, a standard ½-inch nut shall be welded to the inside of the shaft so that it is readily accessible from the handhole.

12. Each pole shall be furnished with three pole bands for attachment of traffic signal span, minor cable span, and service rack. No more than one of these items shall be attached to each pole band.

B. **Strength Requirements.** The standard shall be designed so that it will withstand a minimum transverse load of 3700 pounds applied 18 inches below the top of the shaft without exceeding the elastic limit. The deflection of the shaft shall not exceed 0.40 inches per 100 pounds of transverse load applied at the same point.

C. **Air Circulation.** Provisions shall be made for free air circulation inside the shaft to remove moisture caused by condensation or from other sources.

D. **Anchor Bolts.**

1. Four high strength anchor bolts shall be furnished with each standard. The anchor bolts shall be 1¾ inches in diameter for 30- and 36-foot poles or 2 inches in diameter for 40-foot poles, and 120 inches long. This length includes a 6-inch "L" bend at the lower end. The anchor bolts shall be fabricated from high strength steel having a minimum yield strength of 55,000 psi. and a minimum ultimate strength of 85,000 psi. and at least 12 percent elongation in a 2-inch gauge length. Each bolt shall be threaded for a

minimum length of 9 inches at the upper end and shall be hot-dip galvanized according to ASTM A 153 for a minimum length of 12 inches after threading.

2. Each anchor bolt shall be furnished with one lock washer, two flat washers and two hex nuts of the Heavy Hexagon Series, meeting the requirements for carbon steel nuts of ASTM A 307, Grade A or stronger. Nuts and washers shall be hot-dip galvanized according to ASTM A 153. Nuts shall be retapped after galvanizing according to ASTM A 563.

3. One anchor bolt per heat shall be furnished by the Contractor, to be randomly sampled and tested by MDOT from all anchor bolts used on the project.

4. Tighten all top anchor bolt nuts to a snug condition defined in subsection 707.03.D.7.c.

E. **Repairing Galvanized Surfaces.** Spelter coating which has been damaged in transporting, handling, or erection shall be repaired by the Contractor without cost to the Department. The damaged spelter shall be cleaned by wire brushing and then painted with two coats of an approved zinc-rich light gray weather-resistant paint.

F. **Identification of Manufacturer.** Each standard shall have a permanent catalog or other manufacturer's identification number on the base.

921.06 Traffic Signal Pedestal. Pedestals shall be suitable for mounting traffic signals equipped with slip fitters for 4-inch nominal size pipe. The overall height of the pedestal shall be as shown on the plans.

The pedestal shall conform to the minimum specifications below, but consideration will be given to features of design, construction, and workmanship. The base shall be designed for a 12¾-inch bolt circle diameter.

The pedestal shall be made with a case aluminum base with an aluminum shaft threaded into the base. The shaft shall be secured tight to prevent loosening or turning after installation by a stainless steel set screw.

A. **Shaft.** Aluminum Pedestal Shaft shall be extruded and meet the following minimum requirements:

Aluminum alloy	ASTM B 308 6063-T6
Tensile strength, (ksi)	30
Yield strength, (ksi)	25
Elongation (%)	10
Wall thickness (in.)	0.237
Outside diameter, (in.)	4.5

Threading and deburring of the pedestal shaft shall be according to the basic dimensions of American National Standard Taper Pipe Threads, NPT (ANSI B2.1).

B. **Finish.** Aluminum pedestals shall not be painted. Aluminum shafts shall have the following minimum finish requirements:

1. **Finish Type.** A tough surface texture consisting of a uniform grain pattern that is perpendicular to the axis of the shaft for the full length of shaft. This is not a mill finish.

2. **Texture Profile.** The grain profile shall have a surface roughness (total profile height from peak to valley) of at least two, but not more than four times the Roughness Average (Ra) which shall be 250 micro inches. Aluminum pedestal shafts shall be free of excessive material; heat discoloration of material; irregular grain spacing, grain patterns, waviness, scratches or marks of varying depths and sizes and holes, ridges, cracks or other surface defects that are not removed in the finish process.

C. **Mill Certification.** Reports to be maintained by the manufacturer and supplied on request.

D. **Hardware.** The pedestal shall be furnished complete with M24 foundation bolts a minimum of ⅝-inch diameter and 21 inches long which includes a 3-inch "L" bend on the unthreaded end.

Foundation bolts shall be equipped with hexagonal nuts and washers. The threaded end of the bolts shall be threaded for at least 3 inches. Bolts shall be electro-galvanized after threading according to ASTM B 633, Service Condition SC 4 for their entire length, or hot-dip galvanized according to ASTM A 153. The nuts shall be galvanized similarly and must turn freely on the bolts after galvanizing.

The access door in the base of the pedestal shall be held in place with an AISI, Type 300 stainless steel machine screw.

E. **Drawings.** Two copies of detailed dimensional and installation drawings shall be furnished to the Engineer.

F. **Packaging.** Threaded end shall have a protective cap to prevent thread damage. Cardboard sleeve shall cover the entire length of shaft to protect surface finish.

921.07 Illuminated Case Signs. Case signs shall have internal illumination furnished by mercury vapor bulbs. The signs shall be designed for operation on 120-volt, single-phase AC electrical systems. Moving components, such as doors, etc., shall have proper fit and free movement.

A. **Hardware.** All fasteners, such as screws, bolts, nuts, hinges, pins and clamps, etc., which are partially or wholly exposed on the exterior shall be AISI Series 300 stainless steel. The mounting hub for the case sign shall be 1½ inch, malleable iron (KK-197).

B. **Ballast.** The ballast shall be the regulator type. The ballast shall be clearly marked, visible when set in the finished case, with the manufacturer's name or trademark, the catalog number, and the complete electrical rating as follows: number of lamps to be controlled, lamp type and lamp wattage, line frequency, line voltage, percent of allowable line voltage variation, line operating amperes, line wattage, power factor, line starting amperes, and the percentage of allowable line voltage dip.

Supplementary markings shall be included to indicate the correct method of connection for the leads.

C. **Face.** The face shall be lexan translucent white, or other plastic material with equivalent or better weathering, structural, and optical properties.

The face shall be 0.125 inch ±10 percent in thickness. Each face shall be marked with the name or tradename of the plastic.

The plastic face shall be furnished blank, cut to proper size, and shipped with the completed case sign.

All sign panels without legends shall be aluminum or as directed by the Engineer. The exterior face shall be coated with a semi-gloss or gloss yellow enamel. The color shall be within the limits shown on the *Highway Yellow Color Tolerance Chart* for the central color, except the color shall be darker than the central color. The interior face shall be coated with a semi-gloss or gloss white enamel.

D. **Wiring.** The signs shall be furnished completely wired. All wiring shall be 600-volt, No. 18 AWG soft annealed copper wire with the following characteristics.

1. Color coded.

2. At least 7 strands.

3. The insulation shall be of 194 °F THHN thermoplastic or 194 °F neoprene and so marked.

The wiring shall be run neatly in flexible aluminum conduit between the ballast box and the socket housing. Where conductors pass through an opening in sheet metal or conduit, a bushing, grommet, or rolled edge shall be provided to protect conductors.

Splices and terminations shall be made only at the terminal block, switch, lampholder leads, or ballast leads. The splices shall be made mechanically and electrically secure by acceptable insulated pressure type, solderless connectors. Terminations shall be made mechanically and electrically secure by acceptable insulated pressure type solderless terminals. Wire connecting screws, tabs, washers, and strips shall be nickel plated brass.

The switch shall be mounted such that it is prevented from turning. A mechanical means other than friction must be employed to prevent the switch from turning.

E. **Painting Requirements.** Prior to painting the case sign, all metal surfaces shall be cleaned and surface treated according to standard industry practice to assure bonding of the paint to the metal.

The coating system shall consist of durable and weather-resistant enamels of the color specified and shall be applied at a uniform thickness without blisters, runs or other defects. The average dry film thickness shall be 1.5 mils and determined by Method A, Inductance

Thickness Gage, as specified in ASTM D 1400. The metal interior of the sign shall be coated with a semi-gloss or gloss white enamel.

The exterior of the sign shall be coated with a semi-gloss or gloss yellow enamel. The color shall be within the limits shown on the *Highway Yellow Color Tolerance Chart* for the central color, except the color shall be darker than the central color.

F. **Packing and Marking.** Each finished sign shall have a permanent legible marking which shall include the supplier's name, trademark, or other suitable means of identification.

Each sign shall be individually packaged in such a manner that it will be accepted by common carriers and there will be no injury or defacement to the sign during transportation. Each package shall be legibly marked with the descriptions of contents and supplier's name.

G. **Inspection.** Inspection, will be performed by the Department. Mill test reports for all aluminum extrusions shall be furnished upon request by the Department.

At the time of delivery, the supplier shall furnish a Type D certification stating that the pretreatment requirements as specified under subsection 921.06.E have been met. The certification shall reference the method and material used in the pretreatment process.

921.08 Traffic Loop.

A. **Traffic Loop Wire.** Loop wire and loop lead-in wire shall conform to subsection 918.03.

B. **Traffic Loop Sealant.** Sealant used to seal and encapsulate detector loop wires in concrete or asphalt roadway surfaces shall be supplied in cartridges suitable for use with a common one quart manual caulking gun or an air powered caulking gun.

The sealant shall be of a polyurethane or silicone rubber type. It shall be one part, moisture curing, and self leveling.

The minimum temperature range for application shall be +40 °F to 100 °F. The minimum service temperature range shall be -40 °F to 200 °F.

It shall have a dielectric constant greater than 6 at 50 Hz and greater than 4 at 500 Hz or higher.

The viscosity shall be 28000 - 48000 cps. It shall be tack free within 24 hours or less after application.

It shall be non-stringing, and ready to be driven over shortly after application.

The sealant shall provide complete encapsulation of the detector loop wires, in a rubber-like environment. Provide protection against moisture, wire movement and damage under normal roadway conditions.

It shall moisture cure to a tough, long lasting seal that effectively resists weather, abrasion, oils, gasoline, anti-freeze solutions, brake fluids, and road salts normal encountered under typical road situations.

The sealant shall remain permanently flexible and not shrink or pull out of the saw cut groves after application. The sealant level shall remain the same over time to assure maximum protection.

C. **Packing and Marking.** Materials shall be delivered in original, tightly sealed containers, clearly labeled with the manufacturer's name, product identification and lot number where applicable. Each case of cartridges shall be packed in such a manner that there will be no injury or defacement to the cartridges during transportation to the project site. Each carton shall be legibly marked with the contents description, and supplier's name.

921.09 Digital Loop Detector/Cabinet. This unit shall meet all current and applicable NEMA standards. The following are the minimum acceptable design and operating requirements.

A. **Loop Requirements**.

1. The loop detector shall be shelf-mounted and have a nominal size of 6 inches high, 6 inches deep, and 2 inches wide.

2. The detector shall start with the application of power and be completed within 60 seconds.

3. The detector loop inductance shall be a minimum of 18 microhenries to a maximum of 2,000 or more microhenries.

4. The detector shall function with up to 4,000 feet or greater maximum loop lead-in. The loop lead-in (feeder cable) shall be two-conductor shielded A.W.G. number 12, and shall meet current I.M.S.A. specification 50-2.

5. The detector operation frequency shall be from a minimum of 25 to 85 kilohertz or greater. A three-position switch will select one of three loop oscillation frequencies. The three loop oscillation frequencies will be one at the high, one near the center and one at the low end of the above mentioned range.

6. The detector shall have a switch to select three levels of detection, these levels shall nominally be as follows:

High	0.01% Inductance Shift
Medium	0.08% Inductance Shift
Low	0.16% to 0.32% Inductance Shift

7. The detector shall be switchable to select two levels of hold time. These levels shall be: 15 minutes for the longest presence to a minimum of 125 milliseconds for all vehicles.

8. The unit shall withstand a ten microfarad capacitor charged to 2,000 volts between loop terminals and chassis ground. The unit shall also withstand a ten microfarad capacitor charged to 1,000 volts across open loop terminals.

9. The delay time on the detector unit shall be able to be set from 0 to 63 seconds in one second increments.

10. The extension time on the detector shall be able to be set from 0 to 15.75 seconds in 0.025 second increments.

11. The detector provides internal diagnostics, identifying and differentiating between an open, a short or a sudden 25% change (drift) in inductance. A separate fault LED is provided to identify three different fault conditions, also present fault or historical fault condition.

12. The unit shall function when 90 through 135 VAC 60 Hertz power is applied.

13. The detector shall have a 1/4 amp SLO BLO fuse.

14. The wire connector on the unit shall be MS 3102A-18-1P with pin connections as follows:

    Pin A - AC (-) White
    Pin B - Relay Common, Yellow
    Pin C - AC (+) Black
    Pin D - Loop, Gray
    Pin E - Loop, Brown
    Pin F - Relay (N.O.), Blue
    Pin G - Relay (N.C.), Red
    Pin H - Chassis Ground, Green
    Pin I - Spare, White/Black
    Pin J - Delay Override (120 VAC 60 Hertz), White/Red

15. Applying 120 VAC 60 hertz power to pin J of the connector, will disable the delay time function of the unit.

16. One wiring harness shall be supplied with each detector. It shall be 96 inches in length minimum and be color coded. This shall be a multi-conductor cable with a PVC outside covering. It shall have a connector on one end that will mate with the connector on the detector.

B. **Detector Cabinet Requirements.** The loop detector shall be furnished completely housed in a cabinet constructed of aluminum. The cabinet shall be a pole mounting type with a nominal size of 7 by 12 by 13 inch.

   All hinges and pins shall be corrosion resistant. The door shall be equipped with Corbin Lock Mechanism Pal 8, or approved equal. Two keys for the lock shall be furnished.

The exterior of the detector cabinet and all mounting attachments shall be finished with a durable and weather-resistant protective coating having a total dry film thickness of not less than 1.5 mils. The final coat shall be aluminum in color, shall give complete hiding and shall be at least 0.75 mils in thickness.

Hardware shall be provided to allow mounting the cabinet on either a wood or steel pole, or on a 4 by 8 inch wood post.

The cabinet shall be designed to permit the detector to be withdrawn from the cabinet for inspection or maintenance without breaking any electrical connection or interrupting normal operation of the detector.

Cabinets shall be furnished without conduit holes.

C. **Functional Data and Parts Lists.** With each loop detector, the manufacturer shall supply each of the following items. Each of these items shall apply directly to the loop detector with which it is supplied.

1. A complete set of schematic and wiring diagrams of the loop detector and terminal facilities

2. A complete set of instructions for installation and maintenance of the loop detector

3. A complete parts list.

D. **Packing and Marking.** Each loop detector shall be packed separately in such a manner that there will be no injury or defacement to the loop detector during transportation. Each carton shall be legibly marked with the loop detector description, contract number, and supplier's name.